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# Internal cocaine trafficking and armed violence in Colombia

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## Abstract

This paper exploits time variation in international cocaine prices and potential trafficking within Colombia to estimate changes in municipality homicide rates.

JEL: D74, K45

This paper proposes a strategy to estimate exogenous variation of homicide rates in Colombia. I use the interaction between internal cocaine trafficking networks and international prices of cocaine in the United States (US) and Europe to predict homicide rates at municipality level.

This work enriches the literature on the causes and consequences of armed violence. I contribute to future research by estimating exogenous shocks on homicides that are orthogonal to local economic outcomes such as household investments.

Internal trafficking represents 75% of the cocaine market added value chain while production adds about 25% (Mejia and Rico (2010)). Thus, I analyze the effect of trafficking on homicides. This departs from previous literature that studied the relationship between cocaine production and violence.

My strategy follows Dube and Vargas (2013) and parallels to the work carried out in Mexico (Dell (2011)). Yet unlike previous literature, this paper exploits the comparative advantage of each municipality when serving different international markets.

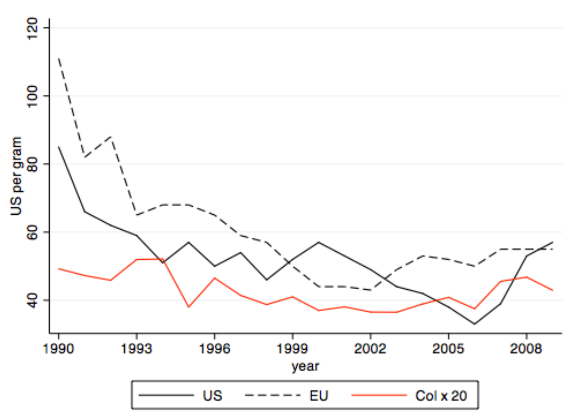
# 1 Conceptual Framework

Violent crime in Colombia is prevalent along drug trafficking routes. Moreover, the routes used by drug traffickers vary over time depending on which international market they intend to supply. This section explains how traffickers' behavior provides exogenous variation of homicides rates.

Firstly, drug dealers compete in regional oligopolies for control of trafficking routes. After the elimination of the great drug cartels in the early 1990s the cocaine market divided into multiple groups, which competed for the regional control of crops and trafficking (Echandia (2013)).

Secondly, violence is used to compete in illegal markets (Kugler et al. (2005); Fiorentini (1995)).[1] When the expected illegal profits increase, rates of violence rise because competitors seek larger market shares.

Thirdly, local drug dealers cannot set prices in the consuming regions. As above, regional competition reduces traffickers power to set final prices. However, I use the price of cocaine in Colombia, which represents the reservation price of drug dealers, to account for effects of supply shocks on final prices. Figure 1 shows the US, European and Colombian wholesale prices of cocaine.




UNODC and Colombian National Police. $Colx20 = Colombian\,price \star 20$

Figure 1: Wholesale price of cocaine

Finally, trafficking only affects local economies as a consequence of the violence used by dealers. I will show that drug trafficking does not create local income effects nor does it explain the behavior of Guerrilla and Paramilitary Armies.

[1] Mejia and Rico (2010) describe the use of violence in the Colombian cocaine market.

## 2 The cocaine network

Define the network $N(O, V, D)$. Origins $O$ are the municipalities with coca bushes from 2001 to 2009 using data from SIMCI (2012). $V$ are the transit points, these are municipalities crossed by the roads used to transport cocaine. Destinations $D$ are municipalities reachable by car at the Colombian border. For sets $V$ and $D$ I use the network of primary and secondary roads in 2005 (Minister of Transport[2]). $z = (o, \bar{v}, d)$ as the route via which a dealer transport cocaine from a producing municipality $o$ to a border municipality $d$ using the road network passing through municipalities $\bar{v}$. At the border, cocaine is sold to an international trafficker. Figure 2 shows the inputs of the network $N$.

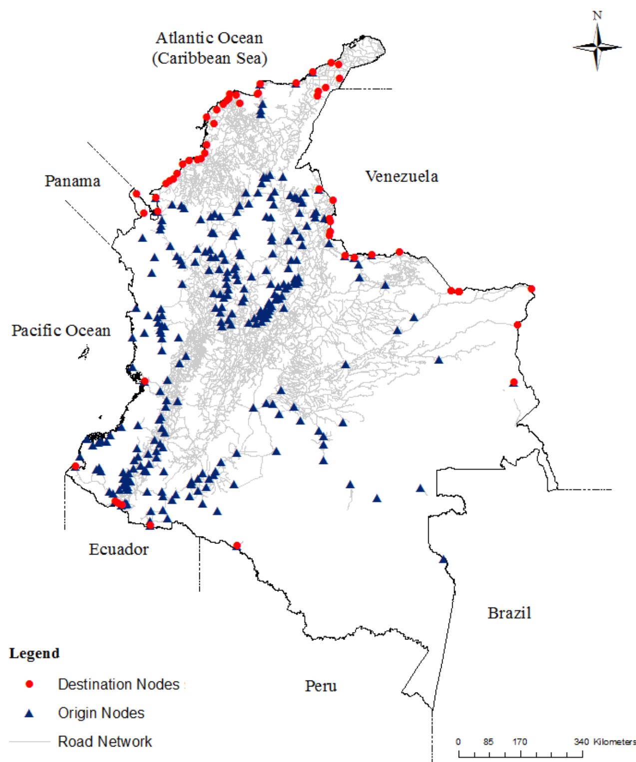



Figure 2: Inputs to construct the Colombian potential internal cocaine trafficking network

To construct the set of feasible routes for cocaine trafficking, I find the shortest route to link each origin with each destination following two predetermined rules of transit. The first rule prioritizes primary roads over secondary roads. The second rule assumes the reverse order.

I found 12704 routes from 224 origins to 47 destinations (table 1). The routes' average length is 1516 km. Routes mainly follow secondary roads because coca bushes are principally found in areas with poor infrastructure.

Table's 1 lower panel describes the set of routes which link each origin with the closest destination. The median length of these routes is 543 km. Therefore, for 50% of cocaine producing municipalities traffickers need to travel at least 543 km.

This network only explains trafficking along roads, excluding rivers and air trafficking. Most trafficking is carried out on roads that lead to sea ports. Almost 80% of cocaine seizures occur on the sea or roads (DNE (2010)).

[2]Data projected using MAGNA_Colombia_Bogota coordinate system.

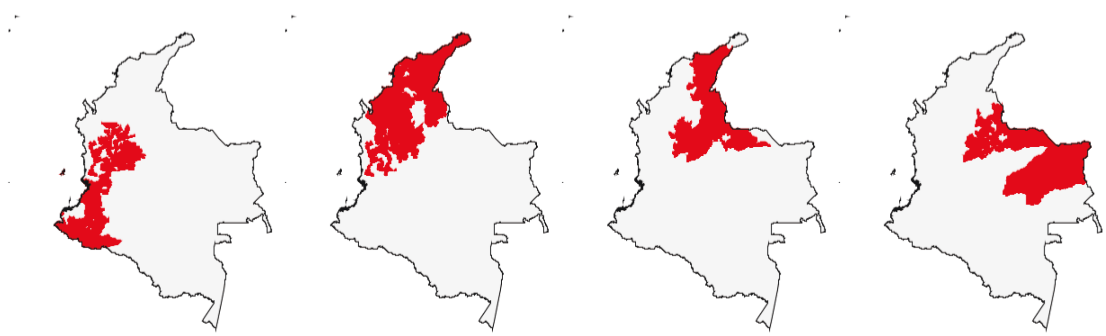
| ***Main features*** | | | | |
|---|---|---|---|---|
| Origins | 224 | | | |
| Ends | 47 | | | |
| Routes | 12704 | | | |
| | ***Mean*** | ***S. D.*** | ***Min*** | ***Max*** |
| Length (Km) | 1516.4 | 791.8 | 28 | 4040 |
| % Main Road | 0.37 | 0.12 | 0 | 1 |
| ***Shortest route distribution*** | | | | |
| | ***Mean*** | ***S. D.*** | ***Median*** | ***p90*** |
| Length (Km) | 568.0 | 338.2 | 543.1 | 1098.6 |

Table 1: Cocaine trafficking network descriptive statistics

# 3 Estimation strategy

This paper exploits time variation in international cocaine prices and potential trafficking within Colombia to estimate changes in municipality homicide rates. To link the internal trafficking network with international markets, I group the routes by the border where each route terminates. Each route will belong to one frontier cluster $f \in F =$ {Pacific, Atlantic, Venezuela North, Venezuela South}.[3] [4]

Distance plays an important role in the choice of the traffickers. Longer routes have a higher probability of being intercepted. Hence, I allow traffickers to use any route shorter than 1020 km to include 90% of the origin municipalities (see table 1). Furthermore, a clear division between trafficking regions is maintained.[5] Dell (2011) uses only the shortest route from each origin to the closest destinations. I do not use this strategy because this would constrain trafficking to one option by origin implying a higher probability of losing the parcel to police or rival gangs. Figure 3 shows the trafficking clusters.



(a) Pacific (b) Atlantic (c) Ven. North (d) Ven. South

Figure 3: Drug trafficking network by cluster

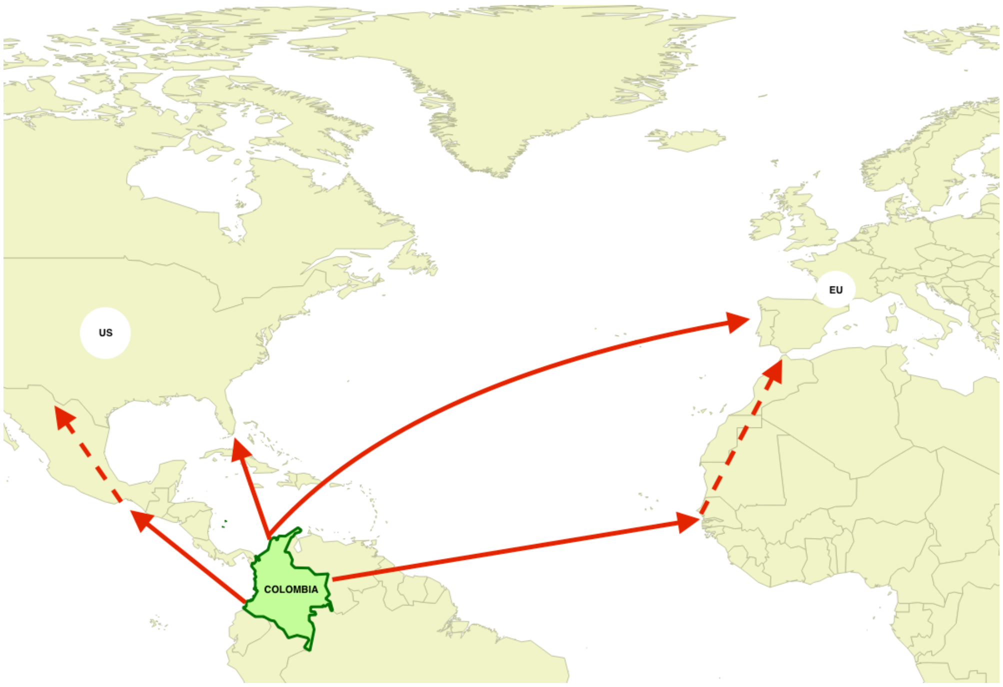
Identification relies on different frontiers having comparative advantage with regard to different international markets. Figure 4 shows the main international trafficking routes.

The map shows that two clusters are clearly linked with a specific market. If traffickers sell cocaine on the Pacific coast the final destination is the US. If cocaine is found at the Venezuelan southern frontier, the final destination is Europe. From 2006 to 2008 51% of cocaine in Europe came from Venezuela. Meanwhile 67% of the cocaine in US came from Mexico (UNODC (2012)).

[3] No route finishes on Panama, Peru or Brazil. Routes finishing at the Ecuadorian border were excluded because taking cocaine to the Pacific coast strongly dominates trafficking through Ecuador.

[4] Venezuela North from Guajira to Boyacá. Venezuela South from Arauca to Guanía.

[5] The online appendix shows results using different maximum lengths.




Source: http://thematicmapping.org, Routes drawn based on UNODC (2012)

Figure 4: International cocaine trafficking routes

Denote, $h_{mt}$ is the homicide rate of municipality $m$ in year $t$. $D_{mf} = 1$ if the municipality $m$ belongs to a route that finishes at frontier $f$ and zero otherwise. $P_{\iota t}$ is the wholesale price of cocaine at market $\iota \in \{US, EU\}$. To account for supply shocks I subtract the wholesale price of cocaine in Colombia from each international price ($P_{\iota t} = p_{\iota t} - p_{COL,t}$). Equation 1 summarizes this approach.[6]

$$h_{mt} = \sum_{\iota} \sum_{f} \beta_{\iota f} P_{\iota t} D_{mf} + \rho X_{mt} + M + T + \mu_{mt} \tag{1}$$

$\beta_{\iota f}$ captures the effect of the price of market $\iota$ over the municipalities involved in the cocaine trafficking to frontier $f$. When $\beta_{\iota f} > 0$ the municipalities in $f$ are serving trafficking to market $\iota$. Contrarily, $\beta_{\iota f} \leq 0$ the municipalities in $f$ have no comparative advantage serving $\iota$.

# 4 Data

I create a panel of homicide rates for all Colombian municipalities (1110) from 1990 to 2009 using data from Colombian Vital Statistics (DANE). Figure 5 shows the annual evolution of the homicide rate in Colombia.[7]

# 5 Results

Table 2 reports the resulting $\beta_{\iota f}$ estimates for equation 1 and the joint significance F test over them. Column 1 shows that when the price of cocaine increases in the US the homicides increase in the municipalities that belong

[6] $X_{mt}$ = municipality controls , $M$ = municipality fixed effects, $T$ = year fixed effects, $\mu_{mt}$ = error term

[7] The online appendix contains the description of the homicide rate and the control variables in the estimations.

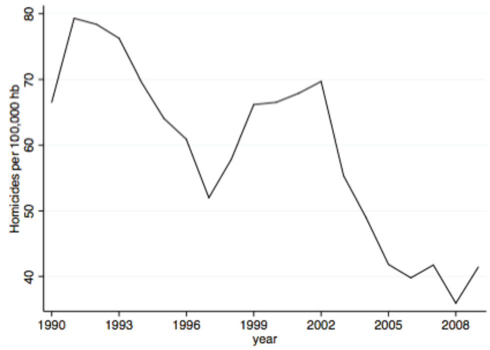



Figure 5: Homicide rate (1990 - 2009)

to the trafficking of the Pacific, Atlantic and Northern Venezuelan border. When the European price increases, homicides on the southern Venezuelan border increase. Column 2 constrains the model only to the market each region serves. The main results remain and the F test rises from 10.8 to 13.3.

| | | Standardized homicide rate | | | |
|---|---|---|---|---|---|
| $P_\iota$ | $D_f$ | Total | Total | Male | Female |
| | | (1) | (2) | (3) | (4) |
| US | Pacific | 0.689*** | 0.645*** | 0.669*** | 0.337*** |
| | | (0.116) | (0.106) | (0.109) | (0.089) |
| | Atlantic | 0.439*** | 0.349*** | 0.363*** | 0.093 |
| | | (0.122) | (0.087) | (0.090) | (0.074) |
| | V. South | -0.090 | | | |
| | | (0.120) | | | |
| | V. North | 0.276* | 0.087 | 0.091 | 0.080 |
| | | (0.150) | (0.107) | (0.108) | (0.102) |
| EU | Pacific | -0.060 | | | |
| | | (0.168) | | | |
| | Atlantic | -0.132 | | | |
| | | (0.168) | | | |
| | V. South | 0.314* | 0.193** | 0.189** | 0.064 |
| | | (0.175) | (0.093) | (0.093) | (0.123) |
| | V. North | -0.261 | | | |
| | | (0.243) | | | |
| F Test | | 10.83 | 13.33 | 13.61 | 3.80 |
| $R^2$ | | 0.50 | 0.50 | 0.50 | 0.22 |

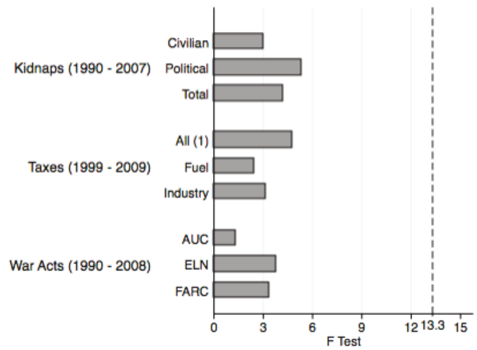
Clustered standard errors in parentheses. * $p < 0.1$ , ** $p < 0.05$ , *** $p < 0.01$

Table 2: Homicide rate on cocaine trafficking network

Columns 3 and 4 show estimation results for homicides by gender. The F tests suggest that drug trafficking explains changes in male, but not female, homicides.

## 5.1 Other effects

This work claims that the only direct impact drug trafficking has on local economies is to increase homicides, which then sparks other effects. I estimate equation 1 using as dependent variable local tax revenues, attacks by illegal armies and kidnaps. Figure 6 shows that the joint significance F test of $\beta_{\iota f}$ of such estimations is always below 5 compared to 13.3 (dashed line) when the dependent variable is homicides. This is evidence of the small effect of cocaine trafficking on war actions and municipality income.[8]




1. Without Land Taxes.

Figure 6: War acts, kidnaps and tax revenues per capita on drug trafficking networks - F Test

## 6 Conclusions

I propose a strategy to estimate exogenous variation in homicides at Colombian municipalities. Using cocaine trafficking researchers can study the causal effect of homicides on wide variety of economic outcomes such as investments choices of firms, households, or political parties.

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[8]Taxes could change if consumption change when income changes. This result suggests that trafficking is not related with local income effects.

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